M. O. Struve.
Prof. Tacchini.
M. J. Thomson.
Chas. Todd, Esq.
M. Y. Villarceau.
Col. Walker.
Prof. Weiss.
Mr. J. Williams.
Dr. R. Wolf.
Prof. C. A. Young.

---

## ADDRESS

*Delivered by the President, William Lassell, Esq., on presenting the Gold Medal of the Society to Signor Schiaparelli.*

You will have learned from the Report just read, that your Council have awarded the Gold Medal this year to Signor Schiaparelli; and I regret to have to inform you that we shall be deprived of the pleasure of presenting it to him in person; as by a letter received from him a few days ago, I learn that his duties of Professor and Director of the Observatory at Milan will prevent his being able to undertake so long a journey.

The first notice I find of Signor Schiaparelli's labours is his discovery of the minor planet *Hesperia*, at the Observatory of Milan, on the 29th of April, 1861, an indication that, besides his mathematical attainments in Theoretical Astronomy, he possesses industry and practical skill as an observer.

In the *Astronomische Nachrichten* of 13th August, 1864 (No. 1487), is a purely mathematical paper by him, entitled, "Théorèmes sur le mouvement de plusieurs corps qui s'attirent mutuellement dans l'espace." Of this paper, not bearing immediately upon those labours of Signor Schiaparelli which have more especially called forth the award, I will only express the opinion of a friend of high mathematical attainments, who characterizes it "as an elegant and probably original contribution to the theory of the orbits of bodies moving freely in space, and acted on only by their mutual attractions."

I come now to give some account of Signor Schiaparelli's principal discovery of the law of identity of meteors and comets, and of the observations and reflections which led him to that result, as contained in a series of letters to Father Secchi in the year 1866.

It appears from these, that Signor Schiaparelli's study of this subject received a great impulse from his own observation of the meteors which fell on the nights of the 9th, 10th, and 11th of August, 1866. He states that he was then confirmed in the opinion expressed three years before, that, of the meteors which usually fall on those nights, a great number are distinguished by

their starting nearly all from one point. And, from the spasmodic fall of these meteors—more sometimes falling in one minute than in the next quarter of an hour—he inferred that their distribution in space must be very unequal. He also observed that those stars proceeding from one point were all of a fine yellow colour, and left behind them a fugitive but very sensible track; whilst the other meteors, proceeding from various points, offered every variety of colour and form. Hence he concludes that the meteors form a number of rings, and become visible when the Earth traverses their orbit, as if shooting forth from one point in the sky. And he remarks that the observations of M. Coulvier-Gravier, and Professor Heis, and of our own countrymen, Professor Herschel and Mr. Greg, have shown that these radial points occur in every quarter of the heavens: therefore these rings or orbits must possess every possible degree of inclination to the ecliptic.

He then proceeds to inquire how such a mass of cosmical matter could become accumulated in the Solar System. This system seems to consist of two classes—the Planets, characterised by but little excentricity of orbit, slight variation in the plane of the orbit, exclusion of retrograde motion, and a tendency to take the form of a sphere (deviating from it only so much as is necessary to preserve the equilibrium of the body)—these characteristics applying also to the secondary systems, with the exception of the satellites of *Uranus*. The second class consists of cometary bodies, which are under no law as to the planes of their orbits, or the direction of their motions. The point most remarkable about them is the extreme elongation of their orbits, most of which are described in stellar space; which seems to show that they did not form part of our system when that was first constituted, but are wandering nebulæ picked up by our Sun.

Signor Schiaparelli further observes that the velocity of the Solar System through space has been shown by Otto Struve and Airy to be somewhat similar to that of the planets round the Sun. Now if a nebulous body or comet in motion were to come within the action of the Sun, it would go round the Sun at such an immense distance from us, that it would remain invisible. Two circumstances might bring it within our range of vision—first, if the comet met the Sun in almost a direct line; and secondly, if it were travelling in a direction parallel to the Sun's motion.

If we suppose a cloud of cosmical matter formed of particles so minute and so widely separated, as to possess scarcely any mutual attraction, to be brought within the power of the Sun's influence, each particle would pursue an elliptic orbit of its own. Those particles which differed most in the *planes* of their orbits, would however possess *nodes in common*, and, in consequence, the particles as they approached the Sun would necessarily approach each other, and when separating again, after passing the node, would at their perihelion passage be still very much nearer than they were when brought first within the Sun's attraction. Those particles which, lying in the same plane, pre-

sented a wide angle with respect to the Sun, would form *ellipses*, the planes of which would be identical; though the positions of the major axes would diverge: and, as a result, the particles at their perihelion would pass in nearly the same orbit, but at different velocities, the originally foremost particle being overtaken by those behind it. Again, those particles which, being in the same *plane*, were also in the same *line with regard to the Sun*—their separation consisting in the variation of their distance from the Sun—would form *ellipses in the same plane*, and having a major axis in the same direction, but of different lengths,—the orbit of the particle *nearest* the Sun being described *within* that of the furthest particle, the result of which would be a difference of speed, and an ever-widening distribution of the particles along the whole of the orbit. This reasoning is illustrated, in the second letter to Father Secchi, by a series of diagrams and figures; and then Signor Schiaparelli proceeds to give a recapitulation or summary of his principal propositions thus:—Celestial matter may be divided into the following classes, 1st, fixed stars; 2nd, agglomerations of small stars (resolvable nebulæ); 3rd, smaller bodies invisible except when approaching the Sun (comets); 4th, small particles composing a cosmical cloud. This last class probably occupies a large portion of the celestial spaces, and the motion of these dust-clouds may be similar to that of the fixed stars. When attracted by the Sun they are not visible unless they receive an orbit which is an elongated conic section.

Whatever may have been the original form of the cloud, it cannot penetrate far into our system without assuming the form of an elongated cylinder passing gradually into a stream of particles. The number of such streams seems to be very great. The particles are so scattered that their orbits may cross each other without interruption and may possibly be always changing like the beds of rivers. The stream, after passing its perihelion, will be more diffuse than before; and, when passing a planet may be so violently affected as to separate or break up and even some particles may assume quite a new orbit and become independent meteors.

Thus meteors and other celestial phenomena of like nature, which a century ago were regarded as atmospheric phenomena —which La Place and Olbers ventured to think came from the Moon, and which were afterwards raised to the dignity of being members of the planetary system—are now proved to belong to the *stellar regions*, and to be *in truth—falling stars*. They have the same relation to comets as the asteroids have to the planets; in both cases their small size is made up by their greater number.

Lastly, we may presume that it is certain that falling stars, meteors, and aerolites, differ in size only and not in composition; therefore we may presume that they are an example of what the universe is composed of. As in them we find no elements foreign to those of the Earth, we may infer the similarity of composition

of all the universe—a fact already suggested by the revelations of the spectroscope.

Signor Schiaparelli further pursues the subject in another and later paper, published in No. 1629 of the *Astronomische Nachrichten*, entitled, "Sur la Relation qui existe entre les Comètes et les étoiles filantes." In this communication he refers to the letters to Father Secchi above referred to, in which he had endeavoured to bring together all the arguments in favour of the opinion of an analogy between the mysterious bodies known as shooting stars and comets.

Signor Schiaparelli, in this paper, proceeds to state, that he is prepared to afford to this analogy a large amount of probability, since there is no doubt that certain comets, if not all, furnish the numerous meteors which traverse the celestial spaces. In proof of this, Signor Schiaparelli quotes from a paper of Professor Erman, in which he has pointed out the method of obtaining a complete knowledge of the orbit described by a system of shooting stars, when the apparent position of the point of radiation and the velocity through space of the meteors is known.

Assuming from the necessity of the case that the orbit of the August meteors must be an elongated conic section, Signor Schiaparelli employs the method of Erman to calculate the parabolic orbit of those bodies; taking right ascension 44° and north declination 56° for the position of the point of divergence, according to the observations made in 1863 by Professor A. S. Herschel. And he proceeds to give the following elements, assuming the maximum of the display of 1866 to be August 10th, 18 hours. Comparing these elements of the orbit of the August meteors with those of the orbit of Comet II. 1862, calculated by Dr. Oppolzer, he exhibits the following remarkable coincidence in each element:—

| | Elements of the Orbit of the August Meteors. | Elements of the Orbit of Comet II. 1862. |
|---|---|---|
| Perihelion Passage | 23 July, 1862 | 22·9 August, 1862 |
| Longitude of Perihelion | ° ′<br>343 28 | °<br>344 41 |
| Ascending Node | 138 16 | 137 27 |
| Inclination | 64 3 | 66 25 |
| Perihelion Distance | 0·9643 | 0·9626 |
| Revolution Period | 105? years | 123·4 years |
| Motion | Retrograde. | Retrograde. |

Although the time of revolution of the August meteors is still doubtful, Signor Schiaparelli, on reference to the catalogues of Biot and Quetelet, deduces a hypothetic period of 105 years, which introduces but small changes in the elements—very inferior to the uncertainty of some of the data on which this determination is built.

In the letters above referred to, Signor Schiaparelli had given an orbit for the meteors of November, assuming the point of radiation as determined in America to be $\gamma$ *Leonis*. But later observa-

tions made with much care in England have shown that this position is erroneous by several degrees; so that that orbit can only be termed a very rough approximation. Assuming, then, that the point of radiation is longitude 143° 12′ and latitude 10° 16′ north—that the maximum of the shower was Nov. 13th, 11h. G.M.T.—and that the period of revolution is $33\frac{1}{4}$ years, according to Professor Newton—Signor Schiaparelli computed the following elements of the meteoric orbit, which he compared with those of the orbit of Comet I., 1866, calculated by Dr. Oppolzer.

| | Elements of the Orbit of the November Meteors. | Elements of the Orbit of Comet I. 1866. |
|---|---|---|
| Perihelion Passage | Nov. 10·092, 1866. | Jan. 11·160, 1866. |
| Longitude of the Perihelion | 56° 25′·9 | 60° 28′ |
| Ascending Node | 231 28·2 | 231 26·1 |
| Inclination | 17 44·5 | 17 18·1 |
| Perihelion Distance | 0·9873 | 0·9765 |
| Eccentricity | 0·9046 | 0·9054 |
| Semi-axis Major | 10·340 | 10·324 |
| Revolution Period | 33·250 years | 33·176 years. |
| Motion | Retrograde | Retrograde. |

The assumed position of the point of radiation of the meteors is the mean of 15 determinations obtained by Professor A. S. Herschel, and given in the *Monthly Notices* of our Society, vol. xxvii. page 19. If this point be advanced 2 degrees in longitude, and 145° be taken in lieu of 143°, the difference of 4 degrees in the place of the longitude of perihelion in the above elements will disappear.

Signor Schiaparelli then concludes his memoir in these remarkable words: "These approximations need no comment—must we regard these falling stars as swarms of small comets, or rather as the product of the dissolution of so many great comets? I dare make no reply to such a question."

In venturing to offer a word or two of comment on this very imperfect *résumé* of the labours of Signor Schiaparelli, it appears to me that we can scarcely speak of them too highly, or overrate their importance. Granting that his hypotheses are correct,—of which indeed there seems to be a very high probability, some of the most difficult questions in the contemplation of the constitution of the universe seem at once, and, as it were *per saltum*, to be solved. To have placed before our view so clear a history of those mysterious bodies—nebulæ, comets, and aerolites, and their several and intimate relations pointed out—is an advancement of Astronomical Science I at least individually had not ventured to anticipate. And a collateral advantage resulting from this splendid discovery, is the encouragement given to the careful and diligent observation of phenomena, even when the prospect of a fruitful result is by no means apparent. Had it not been for the patient, systematic, and intelligent observations of Professor Heis,

M. Coulvier-Gravier, Mr. Greg, and Professor Herschel, Signor Schiaparelli would have wanted many valuable data required in his investigations.

I may finally remark, that an important confirmation of Signor Schiaparelli's conclusions appears in a valuable paper of Professor Adams, in our *Monthly Notices*, vol. xxvii. p. 247, in which from somewhat different data, including some observations of his own, he calculates elliptic elements of the November meteors generally very accordant with those above given.

*The President then delivered the Medal to the Foreign Secretary on behalf of Signor Schiaparelli, addressing him in the following terms:—*

Colonel Strange,—I have the pleasure to present to you the Gold Medal of the Society, which please to receive on behalf of Signor Schiaparelli, and transmit it to him with our best wishes that he may enjoy a long life of successful research and discovery.